

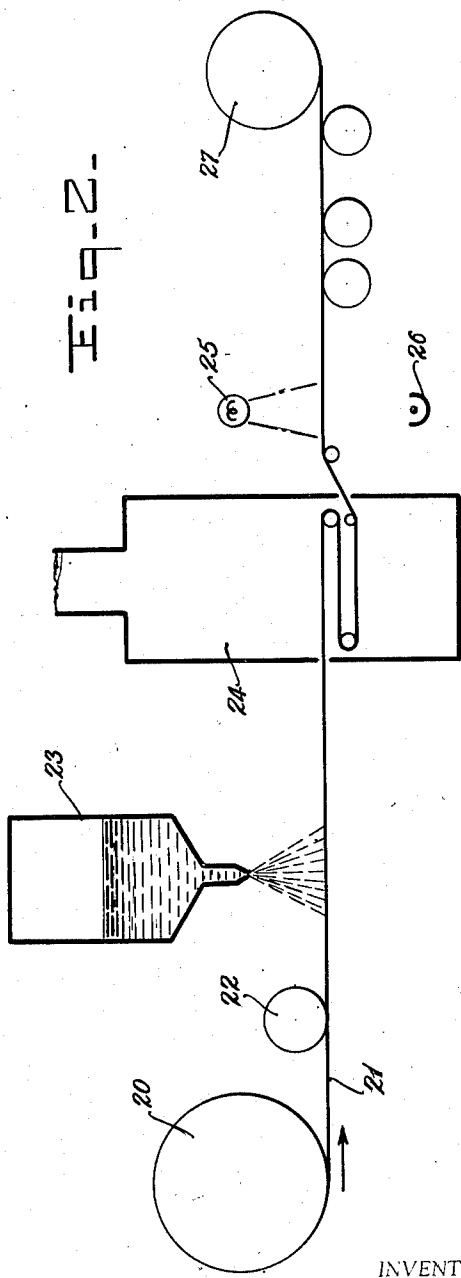
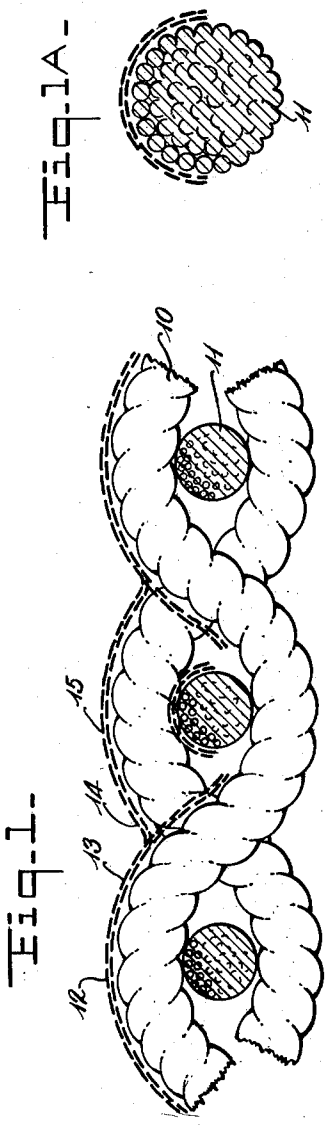
March 10, 1953

H. J. RAND
COATED FABRIC

2,630,620

Filed Sept. 29, 1952

2 SHEETS—SHEET 1



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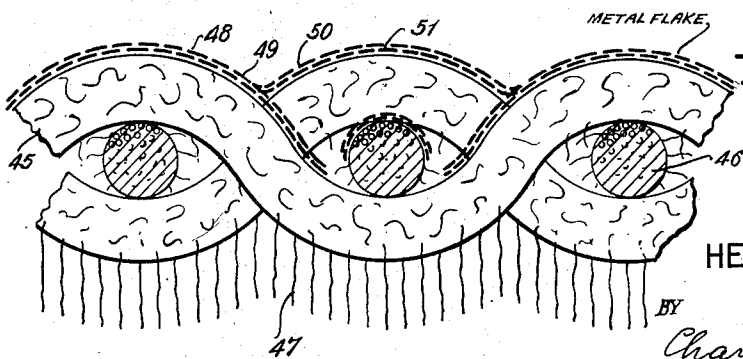
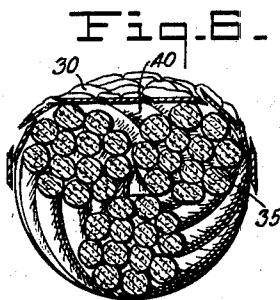
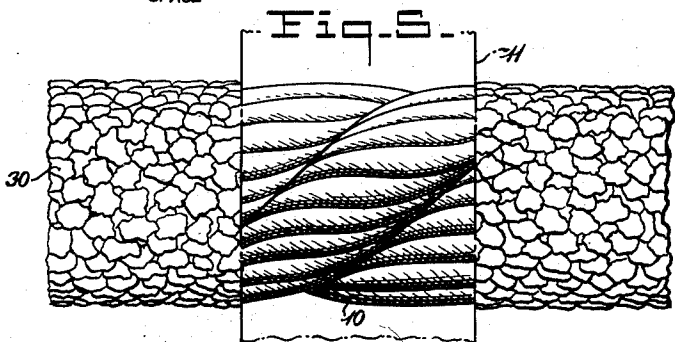
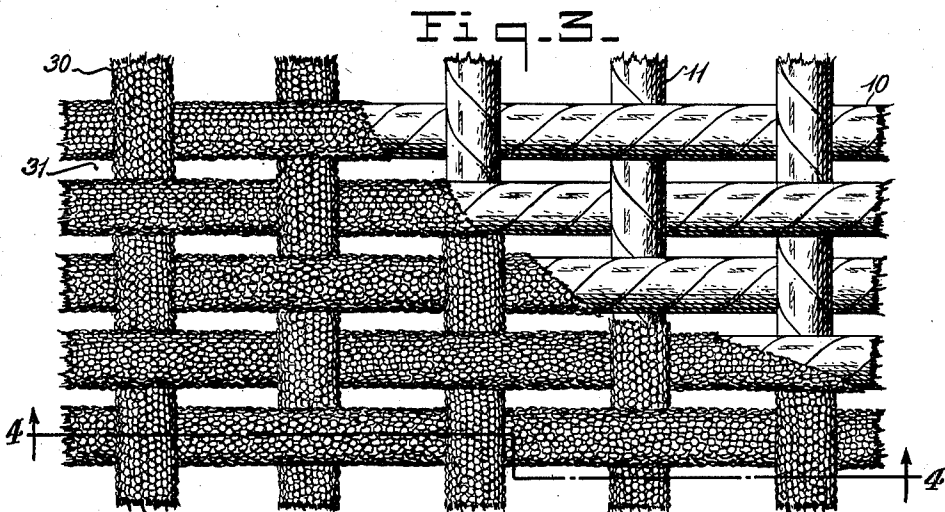
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2 SHEETS—SHEET 2



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2,630,620

COATED FABRIC

Henry J. Rand, Cleveland, Ohio

Application September 29, 1952, Serial No. 311,961

8 Claims. (Cl. 28—80)

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This invention relates to coated fabrics including napped fabrics and such other types of fabrics as hereinafter mentioned by way of illustration and in particular in fabrics which have been coated with a thin application of heat reflective material. This application is a continuation and consolidation of my copending applications, Serial 181,756, filed August 28, 1950, now abandoned, and Serial 191,652, filed October 23, 1950, and now abandoned.

The mechanism by which the body is kept warm or cool by the garment worn is fairly well understood, and it is generally accepted that body temperature is normally maintained relatively constant through heat loss by radiation and heat loss by evaporation of water. For comfort, therefore, a garment must be sufficiently porous to allow breathing or passage of the water vapor. The radiation loss is not subject to control by ordinary textiles, for the garment will absorb radiated heat and reradiate it to the surrounding atmosphere. There have been efforts to devise means for retaining some of this radiant heat close to the body by providing metallic foil reflecting liners or interliners in clothing. In general, however, the efforts have met with no real success, because the reflective foils are impervious to moisture and do not permit the body to remain comfortable. Also metal foils of sufficient strength for use in garments are too heavy with the result that the hand of the material to which they have been applied has been so altered as to make it unusable. Where separate metal foils have been used as interliners in garments, the problem of retaining porosity has not been met, for the metal foils are inherently non-porous and they also change the characteristics of the garments to an extent which makes them unusable.

There have been propositions for impregnating fabrics with metallic compositions for the heat reflection characteristics the metal pigment would give the fabric, but these have met with little success because they too materially alter the hand of a fabric and destroy its porosity by impregnation of the fabric.

Thus, in the various expedients which have been attempted, one or another of the shortcomings has arisen, mainly the hand of the material has been changed; the material has not been suitable for daily use in that its dry cleaning or laundering characteristics have been spoiled; and the porosity has been destroyed.

Accordingly, it is a fundamental object of the instant invention to provide a textile fabric

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bearing a thin superficial application of heat reflective metallic material in which the various shortcomings of coated or laminated textiles have been substantially eliminated or minimized.

It is another object of the invention to provide textile having a heat reflective metal application, which fabric retains the various desirable qualities, such as porosity, hand and cleaning properties, of the uncoated fabric substantially unimpaired.

It is another object of the invention to provide a fabric carrying a metallic application which will serve as an efficient reflector of heat for use under conditions where heat retention of a garment or reflection of heat back to the wearer is desired.

It is a further object of the invention to provide a fabric with a metallic application, which structure will retain substantially all the porosity, pliability, springiness, flexibility, cleaning and creasing characteristics of the original uncoated fabric.

Another object of this invention is to provide coated fabrics in which the fabric carries a relatively deep nap on one side only and is smooth on the other, the smooth side being coated with the thin discontinuous foliated metallic heat reflecting layer as above and hereinafter described, including the methods for producing the same. This embodiment is disclosed and described in my copending application Serial 191,652, filed October 23, 1950.

Other objects and advantages of the invention and the different embodiments thereof will in part be obvious and in part appear hereinafter.

The invention comprises a fabric, such as broadcloth, satin, herringbone weave, chambray, or a fabric having a relatively deep outer nap, to one side of which, normally the inner side, there has been applied a reflective coating of near microscopic or microscopic metallic flakes oriented to be substantially lying in the plane of the surface to which applied to form thereon a foliated layer, the metallic flakes being held on the surface of the material by an organic binder, and forming thereon a superficial coating of metallic flakes juxtaposed and interleaved so as to form substantially at least a single layer of the metallic particles over the superficial face of the material to which applied.

The fibers of each of the fabrics as above set forth to which the metallic coatings can be applied to produce the structure forming the subject matter of the instant invention may be any

of those which are commonly used for making such smooth faced fabrics, and include such natural fibers as silk, wool, cotton, linen, ramie, and napped fabrics and fabrics of synthetic fibers of cellulosic origin, such as rayon, true synthetic fibers, such as polyvinyl chloride, polyvinylidene chloride, and any in that class which are identified generically as synthetic linear condensation super polymers, such as linear polyamides, of which, of course, nylon is typical.

For the metallic flakes to be used in the operation, any of the metals which are inherently malleable, preferably corrosion resistant, of high reflectivity, and can be worked into fine leaf or flake form, such as aluminum, gold, silver, copper, iron, steel, stainless steel, brass, Monel metal, zinc, or platinum, may be used. However, in the selection of the metal flake, considerations of economics as well as operative characteristics will dictate the selection of a metal which is light, corrosion resistant and easily available commercially, such as aluminum or bronze flakes.

The binding ingredient for holding the metallic flake in place may be any film forming polymer, plasticized or unplasticized, even including some of the synthetic polymeric materials commonly used as fibers for textile manufacture. Upon dispersion or solution in a suitable solvent with the metal flake in suspension, there is formed a metallic composition which, after the solvent has evaporated upon application, forms a thin metallic layer composed of metal flakes bound in place by the polymer.

The following synthetic film forming polymers may be used as the binding agent: vinyl polymer types, such as polyvinyl chloride, polyvinyl acetate and copolymers of the vinyl compounds with other film forming compounds, vinylidene chloride, and even substituted vinyl compounds, such as polystyrene; acrylic acid resins, such as methyl, ethyl, propyl, butyl, acrylates or methacrylate and various copolymers thereof; alkyd resins such as the condensation products of glycerol and phthalic acid or anhydride; linear polyamides, the best known of which is nylon; organo silicon polymers such as polymethyl siloxane; melamine resins characterized as condensation products of melamine and formaldehyde.

The invention thus is embodied in a fabric, smooth or napped, having applied to one face thereof a layer of metal flakes in sufficient amount to lay over the superficial surface a large number of the flakes juxtaposed and interleaved to form a layer on the face of the material, bound thereto with a small amount of binding agent so that the fabric retains its original physical characteristics to a substantial degree and displays a marked improvement in heat retaining and reflecting ability.

Reference to the drawings accompanying the instant specification will lead to a fuller understanding of the precise nature of the invention and construction of the product.

In the drawings:

Figure 1 with 1a is a representation of a section greatly enlarged taken through a piece of woven material showing the warp and weft threads;

Figure 2 is an illustration substantially in diagrammatic form of apparatus and method used in a practical method of applying the reflective metal to the fabric;

Figure 3 is a plan view of the woven material shown in Figure 1;

Figure 4 is a sectional view taken on the line 4-4 of Figure 3 illustrating the direction of spray,

the manner in which the threads are partially covered with metallic particles by the spray and also showing the interstices at the intersections of the threads created by the application of reflective metal;

Figure 5 is a greatly enlarged section of one of the threads of the weave after coating with the metallic film but indicating that the said thread is free of metallic particles at the portion thereof covered by an intersecting transverse thread; and,

Figure 6 is a section view of the thread shown in Figure 5 illustrating the separate filaments which make up each of the threads and the manner in which the metallic layer coats one side of each of the threads, creating additional air spaces and leaving intact the natural interstices between such separate filaments;

Figure 7 is a plan view of another embodiment or modification of my invention substantially enlarged and illustrating a fabric having a relatively deep nap on one side and being smooth and coated with the same thin discontinuous layer of foliated heat-reflecting material as disclosed in Figures 1 and 3 to 6 and applied by the apparatus and method as illustrated in Figure 2.

Referring now specifically to Figure 1, it will be observed that the fabric which may be any of the various types of fabrics heretofore mentioned including a napped fabric consisting of the usual warp and weft running in mutually perpendicular directions, and in the figure, 10 represents the warp and 11 the weft. Diagrammatically shown in the figure is a series of flakes 12, 13, 14, 15, etc., applied to the superficial exposed face of each of the threads and following the warp down toward the weft. Therefore, these individual flakes form a discontinuous metallic film 30 as indicated in Figures 3 to 6 inclusive. At the same time, the exposed face weft also is covered with flakes with the result that the face of the fabric is covered with a superficial foliated layer of metal flakes, but the interstices created by the crossing of the threads remain open to leave the porosity of the fabric substantially unimpaired. Thus referring to Figures 4 and 5, it is seen that the spray, having its direction of application projected from the vertical, does not coat or cover the individual thread 10 at the portion thereof which such thread lies underneath the transverse crossing thread or at points of intersection of the threads. The space which remains uncoated by the spray is so indicated in this figure and designated by numeral 32. It is to be understood, of course, that these figures are purely diagrammatic, and illustrate the preferred thinking as to the mechanics of the arrangement of the threads in the cloth and the flakes adhered thereto. The diagram is based on microscopic examination of sections taken through coated fabrics, and, as indicated, a superficial metallic flake layer at least about one flake thick is adhered to the faces of the interwoven warp and weft seen when they are observed vertically. The visual effect is that of a continuous coating, but when examined against a light, the fabric shows the openings at the intersections of the threads.

In Figure 2, illustrating a practical apparatus for coating any of the fabrics of the types herein above mentioned including napped fabrics, 20 represents a roll of fabric from which fabric 21 travels in the direction indicated by the arrow. In its passage to roll 22, the fabric 21 passes across the line of discharge of a spray 23, or series of sprays, which eject a composition comprising a suspension of the metallic flakes in a solution

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of the binder. The desired amount of metallic flake per unit area of material is deposited by regulation of the several variables, such as rate of movement of material, rate of spray, and composition of material sprayed. Also, the line of travel of the fabric will take it through a drying and baking zone 24, which may be an ordinary drying oven or, if desired, may be a bank of infrared heating lamps which will bake off solvent thinner in the metallic suspension sprayed onto the surface of the material, and thus finish the process. The drying of the sprayed coating may require as long as 10 to 20 minutes to remove solvent. Following this the material is baked at a temperature of 350° to 390° F., the precise baking temperature being related to the specific binder used, to finish the coating operation. The effect of the final baking is to remove the final traces of solvent and to induce incipient fusion, at least, of the binder so that firm adhesion of the metal flake to the surface of the material is obtained.

The fabric embodying the invention either smooth or napped on one side as herein set forth is heat reflective but air permeable because of the composition used in making the application as well as the controlled manner of depositing it. In the course of preparing the fabric, it is found that the final baking shrinks and clinches the metallic application onto the outer points or surfaces of the fabric weave, while the interstices remain substantially free of metallic particles, thereby providing minute apertures or pores for the passage of air therethrough. The natural interstices or openings in the fabric between the individual threads are designated by 31 in Figure 3. They remain free of metallic particles and thus, insofar as these interstices be concerned, the fabric retains its porosity. It is found the metallic particles cover the larger part of each mound where a warp thread surmounts a woof thread or vice versa. Microscopic examination reveals that a metallic particle or aggregate of particles covers the complete surface of each thread up to a point which is somewhat short of its juncture with a thread crossing it laterally. Since the juncture point is the place where there is air transfer through the fabric, the resulting fabric carrying the metallic application and containing these air transfer points or pores is permeable to the extent determined by the spraying techniques described. At the same time, since the metallic particles cover the major superficial area of each thread, it is found that the fabric is efficiently utilized for reflective purposes. In this manner both qualities of permeability and heat reflectivity are obtained without impairment of either characteristic.

Figure 1, showing a greatly enlarged cross sectional view of a fabric, indicates the manner in which the metallic particles are fixed upon the individual threads. It is seen that where shrinking has occurred and where the metallic particles extend somewhat away from the fabric thread, an air pocket is formed bounded by the thread and metallic particles, thus entrapping air which serves as an excellent insulating or heat absorbing medium. In the case of a napped fabric, the nap aids in retaining air close to the fabric. Where air is entrapped at these points, any heat absorbed by the pocket of air may be reflected back by the metallic particles thus increasing the efficiency of the coated fabric as a heat barrier. At the same time permeability

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is provided since the metallic particles do not completely cross over the interstices provided by the juncture of the warp and woof threads.

The air pockets spoken of in the foregoing are clearly shown at 40 in Figure 6, where it is seen that the film of metallic particles which envelops the upper surface of each exposed thread forms air pockets 40 between the separate filaments of each thread and said film. As herein shown, as well as in Figure 1a, each of the threads is composed of such separate filaments. Furthermore, the light coating of metallic particles on the exterior upper surface of each thread does not fill nor impregnate any of the natural openings in between these filaments of the threads, such as openings 35, shown in Figure 6.

It is apparent that the method of application involves the balance of a number of variables including, composition of the metallic application, distance of spray heads from the fabric, pressure applied to the spray heads and rate of travel of fabric past the sprays. Briefly, it may be noted that air pressure in the sprays should be such as to induce formation of discrete droplets of the composition and rapid evaporation of solvent. The fabric rate of travel should be such as to permit deposition of a light uniform application thereon.

Suitable controls for regulating the amount of metallic suspension applied to the material and the rate and degree of drying call for a balance of variables which is readily attained by those skilled in the art. For inspection of the finished product, examination thereof in terms of added weight per unit area of cloth, may be made, but inasmuch as the additional weight is normally almost insignificant, a radiation measurement based on a change in reflective properties or transmission properties is far superior, for it is more closely related to the ultimate function of the coated material. For this purpose, a radiation source 25 and detector 26 may be placed beyond the drying oven to measure the extent to which the material has been coated. Finished material is gathered at 27.

A simple guide to the regulation of the amount of metal to be used is to apply to each unit area of material at least the weight of metal which has that area. The factor giving the area per unit weight of metal flake in accordance with a specific state of subdivision is usually obtainable from the manufacturer. If the metal flakes then adhere with a minimum of overlapping, the material will have a layer of metal corresponding in thickness to the thickness of a single layer of flakes. Because foliation of the metal flake occurs in application, the amount is best increased by a factor of 2 to 10.

For making up a suspension of metallic flakes to be used in preparing a coated material, it is well to observe the precaution that the solvent used for making up the metal coating composition should be one which will not dissolve the fabric to which the coating is applied. Normally, no difficulty is experienced with the natural fibers, for they are unaffected by the vast majority of hydrocarbon, alcohol, ether and ketone solvents. The problem of damaging the fabric by means of the solvent used in preparing the metal flake suspension is encountered in the coating of the fabrics made from synthetic fibers, for these are initially formed by precipitation from solution, so normally there are solvents which will dissolve the finished fabric.

The polymer used as the binding agent should

be of a sufficiently high molecular weight to be solid at ambient temperatures, which means it should have a molecular weight exceeding about 2500 or 3000. On the other hand, however, it is best that the molecular weight be not too high, for extremely high molecular weight polymers, those of several hundred thousand, are of such limited solubility in the common solvents that they render them too difficult to use. Also they are so frangible that they do not form flexible films without plasticizers. Normally polymers having molecular weights of the order of 5,000 to 10,000 or 20,000 will be adequate for the purpose. A further criterion of a suitable molecular weight for the polymer is that it should be solid and dry to the touch at ambient temperatures and reach a state of incipient fusion at a temperature level which will not injure the fabric to which it is applied.

The general formula for preparing the solution of binder in which the metallic flake is suspended involves dispersing the finely divided polymer in a solvent for the polymer, and a small amount of plasticizer, and milling or mixing while raising the temperature slowly to about 50° C. to form a clear solution or stable organosol. The smallest amount of binder which will give effective adhesion of the flake should be employed. Usually the weight of binder should be at least about the weight of metal flake used, but amounts from 2 to 10 times that weight will do. Hydrocarbons such as benzene, toluene, xylene or others of similar aromatic nature, serve as extenders of the primary solvent for the binding agent. To a solution of the binding agent of this type there is added the metal flake in finely divided form preferably 300 mesh or finer, to form the suspension which is used in the coating operation.

The proportioning of ingredients for coating any of the fabrics heretofore mentioned will be best understood from the following few typical examples:

Example 1

105 parts of polyvinyl chloride having a molecular weight of about 8000 is dissolved in 145 parts by weight of toluol, and to this is added a paste made by wetting 21 parts by weight of aluminum flake of at least 300 mesh with 29 parts by weight of toluol. The solution thus formed will have the aluminum flake in suspension in a 39 per cent by weight solution of polyvinyl chloride and is ready for being sprayed onto a material. It is to be understood, of course, that variation in the amount of thinner used in the process will develop different viscosities for ease in spraying. Similarly variation in the amount of resin will effect that result. Any of the metal flake materials mentioned, such as bronze, steel, copper, silver, etc., may be used.

Also, it should be understood that the various metal flakes will have widely different specific gravities and may have quite different areas per unit weight, so that adjustment of the proportions of resin and solvent to carry the metal powder will be in order. Where a relatively heavy metal such as copper is used, it may be necessary to prepare a spray suspension having a lesser proportion of solids and possibly a higher viscosity than that described. This, of course, is readily adjustable by persons skilled in the art. Polymers for use in formulating the composition for the metallic application can be conveniently used if first prepared as organosols or pastes which are characterized as dispersions of the

organic polymer in a plasticizer. Polyvinyl chloride organosols are good examples of this kind of formulation.

Briefly, a polyvinyl chloride organosol is prepared from conventional emulsion polymerized vinyl chloride which, if necessary, is reduced to the desired state of subdivision by grinding after drying. The polymer powder is mixed with the plasticizer in any suitable mechanical mixer for such materials. In this mixing operation the polyvinyl chloride particles are dispersed in the plasticizer to produce a high viscosity paste. As may be needed, the viscosity of the paste is reduced by blending with additional plasticizer. The paste can also be prepared by polymerizing the starting material in the presence of the desired plasticizer. When prepared in this form with any of the common plasticizers, the paste is very useful in formulating the binding compositions for the metallic application characterizing this invention.

Example 2

Another formulation of vinyl polymer for use in the preparation of the coated fabric is based on polyvinyl chloride copolymer, containing 95 per cent of vinyl chloride copolymerized with 5 per cent of vinyl acetate. The amount of acetate which may be used in the composition may be as much as 10 per cent or more. Sixty nine (69) ounces of this resin, having molecular weight of about 10,000 to 20,000, is blended with 20 fluid ounces of dioctyl phthalate (2-ethylhexyl) as a plasticizer. To this composition is also added a heat and light stabilizer in the amount of 3½ ounces. The heat and light stabilizer is preferably any of the complex substituted phenols commonly used as an inhibitor in such compositions, such as epichlorhydrin bisphenol complex. The blend of polyvinyl chloride, plasticizer and heat and light stabilizer, is solvated in a mixture of a solvent and non-solvent for the resin. The proportions of the solvent and non-solvent should be balanced against each other so that the formation of a gel is avoided, which can happen when too much solvent is used, or the formation of a precipitate when too much non-solvent is used. Typical proportions are 9 fluid ounces of butyl Cellosolve (ethylene glycol monobutyl ether) as the solvent for the plastic material, which is then extended with 76 fluid ounces of solvent naphtha to form the coating composition. When made up in this fashion and ground in a ball mill at a temperature below about 50° C. to a 6-grind on Hegmann gage, the viscosity of the composition so formed will be about 65 seconds on a No. 4 Ford cup. When prepared in this fashion, the composition shows a particle size of about 10 microns or smaller. Its density is about 8.8 pounds per gallon and total solids content about 56.6 per cent by weight. For use as the vehicle for spraying, the metal flake is wetted with a hydrocarbon extender and blended with the composition and the whole adjusted to a desired viscosity for spraying. In the preparation of coating compositions in accordance with this example the amount of solvating mixture is kept about in the range from 45 to 55 per cent by weight, in which about one volume of solvent to about 3½ to 4½ volumes of hydrocarbon non-solvent are employed.

Example 3

For making a usable composition employing methacrylate polymers, 25 parts of polymethyl

methacrylate, molecular weight about 2000 is dissolved in 225 parts of acetone. Such a 10 per cent solution will have a relatively low viscosity and serve as the vehicle for 20 parts by weight of aluminum flake of at least 500 mesh suspended therein.

Example 4

An effective coating composition is made by forming a solution of 10 parts of linseed oil modified alkyd resin, a glycerol maleic anhydride product of apparent molecular weight 5,000, in 90 parts of toluol to give a 10 per cent solution. The binder can be modified by blending it with 50 parts of a 50 per cent solution of a melamine formaldehyde condensation product in butanol or isobutanol. To the total blend there is added 50 parts by weight of aluminum flake of 300-400 mesh, to form the composition for the metal application to the fabric.

Example 5

Silicone resins may also serve as binders and because they are readily soluble in aliphatic and aromatic hydrocarbons, show low viscosity in solution and wet solid materials easily, they have some advantages. A solution of 20 parts by weight of an ethyl silicone resin, molecular weight about 3000, in 200 parts by weight of petroleum ether serves as a vehicle for about 25 parts by weight of metal flake.

Example 6

The polyamide resins characterized by nylon, though they find their greatest utility in fibers for weaving fabrics, can also be used as binders. Thus a solution of 15 parts by weight of nylon polymer, typical fabric composition for example, in 200 parts by weight of acetone serves as a vehicle for about 20 parts by weight of metal flake.

It is to be understood that in any of the examples, the polymer could be used with a plasticizer in amounts of about 10 to 150 per cent of the polymer.

From the preceding examples, the general principle governing the formulation of the binder composition for the metal application will be seen as requiring solution of the polymeric binder in a volatile solvent to give a low viscosity consistent with retaining good spraying characteristics and quick drying when the solution is sprayed. There should be sufficient binder present to hold the metal flake on the surface of the fabric and, generally, the amount of binder will vary with its identity, but will be in the range from a weight about equal to that of the flake used to about 5 times that weight.

The choice of binding agents is wide, and with the common solvents permits a wide variety of combinations which allows for adjustment of volatility of the composition to match the processing of the fabric. Typical hydrocarbon solvents are benzene, toluene and xylene which represent a moderate choice of aromatic solvents; aliphatic hydrocarbons such as petroleum ether, hexane and Stoddard solvents have only limited solvent power for many polymers and for that reason are not useful as the volatile aromatics. Ester solvents include methyl formate, ethyl acetate, amyl acetate, isobutyl propionate, butyl lactate, and are quite useful but relatively expensive. Also the various Cellosolves, such as ethylene glycol monethyl ether, propylene glycol monethyl ether, etc. Similarly, chlorinated hydrocarbons such as methylene chloride, chloroform,

carbon tetrachloride, ethylene dichloride and chlorobenzene may be used. Ketones such as acetone, methyl ethyl ketone, cyclohexanone and similar volatile ones find use as solvents in the composition. Certain volatile ethers such as diethyl ether, dioxane, or diisopropyl ether also may be used. Certain alcohols such as isobutanol and cyclohexanol and even some acids have some use as solvents for some resins. The classes of solvents may also be used in admixture with each other consistent with the principles set forth.

Though the choice of solvents is wide, it will usually be governed by cost and volatility to match the processing rate of the fabric. Also the polymers vary in their solubility in the various solvents. Briefly, the composition to be used for spraying the coating on the fabric should be of a viscosity which permits it to break up into a cloud of discrete droplets and the volatility of the solvent should be such that it evaporates substantially as fast as the composition strikes the fabric.

Common plasticizers which may be used in the coating composition in amounts of about 10 to 150 per cent or more of the binding agents are: abietic acid esters, castor oil, tung oil, linseed oil, soy bean oil, as typical natural products; dimethyl phthalate, dibutyl phthalate, dioctyl phthalate (2-ethyl hexyl), di-B-butoxy ethyl phthalate and various mixed phthalates, butyl stearate and related esters, methyl glycolate and tricresyl phosphate as typical esters.

The method of application of the foliated metallic flake coating to the fabric, either smooth or napped on one side, has been specifically described in the instant case as based on spraying of the composition by means of conventional spray equipment, but other techniques, such as roller or printing operations are feasible. For example, a variation of the technique is to apply a first light coating to the fabric, which may be clear binder, prior to the reflective coating over the reflective layer is sometimes desirable. The spraying operation has the virtue that the pressure of the spray tends to lay the flakes of metal on the superficial surface of the textile fabric as represented by the tops of the threads in the weave and does not penetrate into the interstices of the individual fibers or filaments or the openings defined by crossing of threads, which leaves the fabric pliable and porous. Since it is important to apply a predetermined amount of the material per unit area of the fabric to insure retention of its porosity, close control of the amount of metallic flake and binder deposited per unit area of the fabric should be observed. This cannot be stated generally, for it varies with the weight of the material and the degree of reflectivity desired to be developed. In general, the reflective coating is substantially uniform over the entire superficial area of the textile fabrics and is the equivalent of at least about a single layer of the metal flake over the superficial surface of the material. Measurement of the amount of deposition can be based on the altered weight of the fabric, but as pointed out above, it is best controlled by means of a measurement of either transmitted or reflected radiation.

Following the coating operation and drying of the coating, it will be observed that the fabric will develop a slight stiffness somewhat resembling that of lightly starched material, but this is readily overcome by distorting the material, for example, through application of tension on the bias. The result is that the coherence among particles of binder, formed by the discrete drop-

lets of the spray, holding metal flakes on the fabric is broken but the adherence of the flake to the fabric is undisturbed and the tiny microscopic particles of binder permit the fabric to develop its original pliability.

The effect of the coating on textiles as demonstrated by examination and test is to give the coated side the color of the metal flake and, thus, most of the metals give the material a gray cast; the bronze and copper flake gives it a yellowish or reddish cast.

Tests indicate that coating a material with aluminum flake reduces the heat loss through that material by amounts up to 33 per cent. The value of employing an aluminum coated rayon, for example, as a lining in a coat, is apparent, for the garment with no material increase in weight is made substantially warmer. In some tests made with lining type rayons, it was found that a rayon satin lining material carrying an application of aluminum flake, as described above, was the equivalent of a similar coat lining made from standard 10 ounce woolen material.

Some measurements on heat transfer by radiation through typical fabrics gave the following results: nylon, 1.5 gram calories per square centimeter per second; rayon, 1.2 gram calories per square centimeter per second; cotton, 0.9 gram calorie per square centimeter per second. Following treatments to coat the materials with aluminum flake, as described, these factors were reduced to about 0.2 gram calorie per square centimeter per second.

An empirical porosity test for the coated fabric may also be used as a control. Thus a sheet of uncoated fabric is placed across the face of an air duct in which a stream of air is flowing at a standard velocity. The pressure drop across the cloth is noted. Comparison of the pressure drop obtained under like conditions of air flow with coated fabric is made. The increase in resistance due to the coating should not exceed 10 per cent if the fabric is properly coated and its porosity substantially retained.

As above stated, Figure 7 illustrates a plan view of another embodiment of my invention. As here disclosed the discontinuous film of foliated heat reflected metallic flakes is applied to a fabric having a warp 45 and weft 46. This fabric has a substantially deep nap indicated by the reference character 47. The nap is preferably on the outer side of the fabric. The heat reflective discontinuous foliated metallic film is indicated by the reference characters 48, 49, 50, and 51. It is preferably applied to the inner or smooth side of the napped fabric. It is precisely of the same type and takes the same form as shown in Figure 1 and Figures 3 to 6 inclusive as described heretofore in this specification. It has all of the same desirable features and characteristics and is precisely the same coating as has heretofore been described in connection with the description of Figures 1 and 3 to 6, inclusive. It is applied to the fabric by the procedures heretofore set forth and by apparatus such as is disclosed in Figure 2 or otherwise described in the specification.

The relatively deep nap on the fabric aids in retaining air close to the fabric. Radiant heat originating on the nap side 47 of the fabric and striking the reflective layer is returned to the body. Warm air is retained by the pockets in the fabric and an interstice formed by crossing the warp and weft threads and by the metal layer.

A common practice of weaving a material is to leave on one surface thereof a relatively heavy nap usually having a fiber depth of several times the thickness of the material to take advantage of a part of the mechanism of heat transfer through a fabric. It is recognized that in any heat transfer phenomena the temperatures adjacent to the heat barrier generally control the rate of heat flow. It is also recognized that a gas film close to the barrier is rather resistive to heat flow. Hence the formation of a fabric having a heavy nap on one side tends to entrap gas at that surface and thereby retard the rate of heat loss through the fabric. Thus the path of heat flow would be through the threads, the warp and weft, and then through the fibrous layer constituting the nap with its gas film. A little appreciated factor in designing fabrics for true warmth is the fact that this structure provides no barrier for radiant heat which is lost from the body. Thus by the application to the face of a fabric opposite from that carrying the nap of a metallic flake film or layer as herein illustrated and fully described the radiation loss through the fabric can be materially reduced and the efficiency of the fabric for maintaining a body warmth improved.

Although the instant invention has been described with only a few examples and a relatively few embodiments, it is to be understood that variations in the fabric and structure thereof may be made without departing from the spirit or scope of the invention.

Details of a preferred process for depositing the metallic heat reflective application on the fabrics are set forth in my co-pending application, Serial No. 277,834, filed March 21, 1952, as a continuation of my application, Serial No. 181,755, filed August 28, 1950, and now abandoned.

What is claimed is:

1. A pliable, porous and heat reflective fabric comprising a preformed textile weave of fibrous warp and weft threads, a discontinuous film composed of a multiplicity of heat reflective metallic flakes applied to one side of the fabric, a binder between the heat reflective metallic flakes and the threads to adhere said flakes to the threads, the opposite side of the fabric being substantially free of said metallic flakes and binder, said fabric being permeable to moisture, the film of metallic flakes being adhered to the outermost fibers of each of the individual threads of said fabric without substantial penetration into the body of said threads, whereby a multitude of air pockets is formed between said film of metallic flakes and said threads, said air pockets being substantially free of said metallic flakes, the warp and weft threads at the intersections thereof providing interstices in the fabric, said interstices and the surfaces of the fibrous warp and weft threads at said points of intersection being substantially free from said metallic flakes, the outer exposed surfaces of the threads of the fabric on the coated side being substantially completely covered by the discontinuous heat reflective metallic film, the metallic film enveloping the upper exposed surfaces of each warp and weft thread but being discontinuous adjacent the areas of intersection of the warp and weft threads, whereby the fabric is porous, pliable and reflective to radiated heat.

2. The product as defined in claim 1 in which the heat reflective metallic flakes cover approximately one-half of the surface of the warp and weft threads.

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3. The product as defined in claim 1 in which the warp and weft threads define substantially large interstices which interstices are substantially free of metallic flakes and in which each of the warp and weft threads is composed of a plurality of filaments having interstices therebetween, said interstices between said filaments being substantially free of metallic flakes forming the film.

4. A pliable, porous and heat reflective fabric comprising a preformed textile weave of fibrous warp and weft threads, a discontinuous film composed of a multiplicity of heat reflective metallic flakes applied to one side of the fabric, a substantial fibrous nap on the other side of said fabric, a binder between the heat reflective metallic flakes and the threads to adhere said flakes to the threads, said other side of the fabric being substantially free of said metallic flakes and binder, said fabric being permeable to moisture, the film of metallic flakes being adhered to the outermost fibers of each of the individual threads of said fabric without substantial penetration into the body of said threads, whereby a multitude of air pockets is formed between said film of metallic flakes and said threads, said air pockets being substantially free of said metallic flakes, the warp and weft threads at the intersections thereof, providing interstices in the fabric, said interstices and the surfaces of the fibrous warp and weft threads at said points of intersection being substantially free from said metallic flakes, the outer exposed surfaces of the threads on said fabric on the coated side being substantially completely covered by the discontinuous heat reflective metallic film, the metallic film enveloping the upper exposed surfaces of each warp and weft thread but being discontinuous adjacent the areas of intersection of the warp and weft threads, whereby the fabric is porous, pliable and reflective to radiated heat.

5. The product as defined in claim 4 in which the heat reflective metallic flakes cover approximately one-half of the surface of the warp and weft threads.

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6. The product as defined in claim 4 in which the warp and weft threads define substantially large interstices which interstices are substantially free of metallic flakes and in which each of the warp and weft threads is composed of a plurality of filaments having interstices therebetween, said interstices between said filaments being substantially free of metallic flakes forming the film.

7. A pliable, porous and heat reflective fabric comprising a preformed textile weave of fibrous warp and weft threads, a discontinuous film composed of a multiplicity of heat reflective metallic flakes applied to one side of the fabric, a binder between the heat reflective metallic flakes and the threads to adhere said flakes to the threads, the opposite side of the fabric being substantially free of said metallic flakes and binder, said fabric being permeable to moisture, the warp and weft threads at the intersections thereof providing interstices in the fabric, said interstices and the surfaces of the fibrous warp and weft threads at said points of intersection being substantially free from said metallic flakes, the outer exposed surfaces of the threads of the fabric on the coated side being substantially completely covered by the discontinuous heat reflective metallic film, the metallic film enveloping the upper exposed surfaces of each warp and weft thread but being discontinuous adjacent the areas of intersection of the warp and weft threads, said warp and weft threads defining additional substantially large interstices, which interstices are substantially free of metallic flakes, whereby the fabric is porous, pliable and reflective to radiated heat.

8. The product as defined in claim 7 in which each of the warp and weft threads is composed of a plurality of filaments having interstices therebetween, said interstices between said filaments being substantially free of metallic flakes forming the film.

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No references cited.